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EFFECTS OF GENERALIZING IN LEARNING.
BILODEAU, INA M.
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*LEARNING EXPERIENCES, *TRANSFER OF TRAINING, *STIMULUS DEVICES, *STIMULUS BEHAVIOR, *COLLEGE STUDENTS, COMPARATIVE ANALYSIS, REINFORCEMENT, MALE, TRAINING, NEW ORLEANS, LOUISIANA

A SYSTEMATIC STUDY OF GENERALIZATION AS A MAJOR MECHANISM OF TRANSFER OF TRAINING WAS CONDUCTED. A NUMBER OF SPECIFIC HYPOTHESES WERE TESTED TO MEASURE THE FORM OF GRADIENTS OF GENERALIZATION IN TRANSFER OF TRAINING, EXTINCTION, AND RELEARNING TESTS. THE SUBJECTS CONSISTED OF 480 MALE COLLEGE STUDENTS WHO WERE TOLD TO RESPOND TO THE SECOND OF A PAIR OF STIMULI. TRAINING AND RELEARNING CONSISTED OF REPEATED PRESENTATIONS OF THE STIMULI. EXTINCTION AND TRANSFER OF TRAINING TESTS USED A COMMON, CENTRAL VALUE FOR THE GENERALIZED STIMULUS IN ALL GROUPS. SUBJECTS RETURNED TO THE ORIGINAL STIMULUS VALUE USED IN TRAINING. FOUR EXPERIMENTS WERE INCLUDED IN THE EXPERIMENTAL DESIGN. EXPERIMENTS ONE AND TWO USED TRANSFER OF TRAINING PROCEDURES AND A SIMPLE, SINGLE VARIABLE DESIGN WITH AN OUTSIDE CONTROL GROUP. EXPERIMENT THREE USED AN EXTINCTION TEST OF GENERALIZATION. EXPERIMENT FOUR USED THE SUBJECTS OF EXPERIMENT THREE IN A RELEARNING TEST OF GENERALIZATION OF EXTINCTION EFFECTS. ANALYSIS OF VARIANCE, TREND TESTS, AND NONPARAMETRIC TESTS WERE EMPLOYED IN ANALYSES. RESULTS INDICATED COMPLETE TRANSFER OF BOTH POSITIVE AND NEGATIVE EFFECTS OF EXPERIENCE WITH A DIFFERENT STIMULUS VALUE. CONCLUSIONS SUGGESTED UNDER SOME CONDITIONS THE STIMULUS VALUES USED IN TRAINING WERE IRRELEVANT TO LATER PERFORMANCE UNDER CHANGED CIRCUMSTANCES. TRANSFER OF CORRECT TRAINING RESPONSES TO CHANGED CIRCUMSTANCES COULD BE COMPLETE. FURTHER RESEARCH WAS INDICATED TO USE THE MODIFICATION OF VOLUNTARY CONDITIONING PROCEDURES AS A TECHNIQUE IN HUMAN LEARNING. (RS)

EFFECTS OF GENERALIZING IN LEARNING

Cooperative Research Project No. 1910

Ina McD. Bilodeau

Tulane University

New Orleans, Louisiana

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Problem. Stimulus generalization is one of the first-order concerns of contempo ary psychology, important theoretically, experimentally, and practically. It is important in theory because of its widespread use in deriving secondary behavioral phenomena and because of the dispute its definition and systematic position have aroused. Some of the dispute is with whether stimulus generalization accounts for discrimination or discrimination accounts for generalization, and some of the disagreement is so great as to suggest that the very definition of learning depends upon the definition of stimulus generalization. Stimulus generalization is important experimentally both because of its theoretical importance and because of the paucity of systematic programs of research, relating behavior to simple variation in stimulus values. And stimulus generalization is important practically for its weight in determining human behavior. Though one may study laboratory learning in the increasing strength of the tendency of a specific stimulus to evoke a specific response, training and education rely on the fact that more than the specific association is acquired, i.e., that there is transfer of training beyond the narrow limits of the specific association.

Perhaps it is the fact of transfer of training, the

applied question, that gives stimulus generalization its theoretical importance. Certainly serious learning theories, in accounting for learning itself, as a discrete association have all first faced the problem that no stimulus is ever exactly repeated: Hull, (1943) for example, proposed stimulus and response generalization to account for progressive increments in a specific $_sE_R$ and solve his stimulus learning and stimulus evocation paradoxes; Estes & Burke (1953) offered probability and stimulus sampling theory to account for learning; and in his explanation of transfer of training through generalization, Osgood (1949) accepted functional identity as the practical substitute for actual identity in attempts at repeating a stimulation. In training and education, transfer of training is a fact, and a fortunate one. It is a fortunate economy that human beings do generalize, or formal education would be life-long, and still inadequate to its purpose. Human beings can learn skills, both verbal and motor, in which new situations are handled as easily as old. The very purpose of education is to produce transfer of training, or generalization of classroom learning to new, or changed extra-classroom situations, in which stimuli, responses, or both, differ from those used in training. If education produced learning, and not learning and generalization, the learning would be largely wasted.

It is apparent, thus, that transfer of training is the very core of education, and it is just as apparent that much of our extra-laboratory behavior depends upon transfer or generalization of previous learning to novel situations. Some of the generalization results in mistakes: a child who exclaims, "The 7 is just like an L!" is wrong, for example. He misses the relevance of spatial orientation in responding to the likeness in form. But the same child is right in other generalization, and he will not only be able to correct mistakes, but to generalize the correction itself beyond the specific error. If "Daddy" is wrong for all but one man, "man" is correct for all, and a child will both drop "Daddy" and use "man" appropriately without being exposed to all men before he does so. (Incidentally, too, the child may learn to recognize or print L faster because he already has acquired 7.)

Extra-laboratory experience suggests that generalization may be underestimated, and that further laboratory work is needed on transfer of learning that is handled as correct behavior, as well as the more usual handling of laboratory generalization as incorrect. Training and education may produce both right and wrong responses in practice, and studying the effects of further training correct generalization is at

least as important as studying the effect of extinguishing incorrect generalizations.

<u>Objectives and hypotheses</u>. One major objective was to determine if transfer of training design would show more generalization than evidenced in extinction tests of stimulus generalization. The hypothesis was that continuing the learning treatment in a transfer test (i.e., substituting a new stimulus but treating the response established with the old stimulus as still correct) might show both (a) more initial generalization than we might expect from extinction tests and (b) delayed generalization in an accelerated acquisition of response to the new stimulus.

The objective was to test, in the same experimental situation, for stimulus generalization and gradients of stimulus generalization both with procedures that allowed differential reinforcement to different stimulus values and procedures that did not differentially reinforce responses to original and generalized stimuli. An important point was the extent to which a gradient of generalization depends on differential training and how generalization gradients develop over trials when generalization is treated as correct versus when generalization is treated as an error. Testing the following specific hypotheses was the objective of the experiments under-

taken. (The statement of the hypotheses in null form does not imply that negative outcome was the experimenter's expectation.)

(a) In a first (test) trial with a new stimulus value, there is no relationship between the amount of stimulus change between training and test (or, there is no gradient of stimulus generalization).

b. Treating responses to new stimuli as correct will not result in a gradient of stimulus generalization either early or late in training to the new stimulus.

c. If there is a gradient of stimulus generalization on the first trial with a new stimulus, treating responses to the new stimulus as correct will have no effect on the gradient in later trials other than the effect predictable from the number of correct responses and initial level of performance to the new stimulus (or, there is no delayed generalization effect).

d. Treating responses to new stimuli as incorrect will produce no gradient of stimulus generalization either early or late in an extinction series to a new stimulus after positive training to another stimulus value.

e. Any relation between stimulus change from training to test and amount of stimulus generalization will not depend

on whether responses to training and generalized stimuli are treated differently.

f. Physical difference between training and generalized stimulus values is adequate for relating generalization to amount of stimulus change.

Related research. For many decades stimulus generalization has provided a topic of theoretical and experimental interest (Spence, 1937; Hull, 1943; Gibson, 1959; Mostofsky, 1965). Yet we remain in considerable ignorance if many fundamental facts and in confusion on major systematic issues.

(a) The confusion, disagreement, and inconsistency begin at the definition of stimulus generalization. The most obvious source of confusion is using the same term to mean both a behavioral phenomenon and a hypothetical process (Lashley & Wade, 1946; Brown, 1965), and Brown has given very convincing demonstrations of the contradictions that sloppy definition produces. A further point on definition, also treated by Brown, is the inconsistency among investigators in stating the required conditions for demonstrating empirical stimulus generalization.

There is considerable hope that old arguments will yield to present reasoning. For example, Brown (1965) and Stevens (1965) sensibly propose studying behavior as a function of a

variety of stimulus, situational, and procedural manipulations, rather than continuing with the circular argument over whether discrimination accounts for stimulus generalization or generalization for discrimination. Certainly, much of the argument should cease with Brown's (1965) statement that two empirical events cannot explain each other, and his examples of cases in which empirical generalization and empirical discrimination are inverse and cases in which they are not inverse functions of each other. The various empirical phenomena may be accounted for by the same theoretical terms, and it remains open to question whether the weight of the explanation will fall on the limits of sensory capacity, attention-training, spread of learning and inhibition, or some neural-physiological alternative.

(b) It follows from the disparate definitions or uses of the basic terms, that the facts themselves are in dispute--i.e., different procedures given the same label may well produce data discrepancies. Fortunately, too, attempts to answer one question may lead to others even more interesting, as for example, Hanson's (1959) findings on height and width of the post-discrimination peak on his exploration of peak-shift phenomena. Thus, we can not yet state with any confidence the shape of empirical gradients of stimulus generalization,

the conditions necessary to produce a gradient of stimulus generalization, and how the shape of empirical gradients changes with the operations used to produce and measure empirical gradients (Wickens, Schroder, & Snide, 1954; Mednick & Freedman, 1960; Butter & Guttman, 1957; Hearst, 1965; Kimble, 1961). There is not even uniformity in choice of the units (jnd or physical) in which the stimulus dimension is to be scaled on the baseline, though the importance of the choice has long been noted (Lashley & Wade, 1946) and though a number of investigators emphasize the importance of the choice of baseline, and the stimulus values used, for quantitative statements of the relation of behavior to variation in stimulus values (Hearst, 1965; Shephard, 1965; White, 1962). Indeed, Shephard deplores the near-absolute lack of attempts to estimate the quantitative relation between response strength and stimulus variation. Physical values of the stimulus are used in the present research for several reasons, including: (a) the priority of S-R over R-R laws; (b) the contradiction in explaining one response measure by another, as a plot of generalization against discrimination implies; and (c) the practical problems in matching one person's generalization-test behavior to another's psychophysical judgments.

Though the majority of studies have produced some form of graded response-strength over increasing discrepancy between values of training and generalization-test stimuli, we can not only question the form of the gradient (Spence, 1937), but its very existence in some cases. That is, it has been maintained, and with good reason, that some form of differential training is needed to produce a gradient and that sometimes no gradient is produced at all (Lashley & Wade, 1946; Wickens, Schroder, & Snide, 1954; Butter & Guttman, 1957). The best experimental approach would seem to be to test for empirical generalization and gradients both early and late in a test period, and with systematic variation in the testing conditions, preferably spacing most of the stimulus values very close to the training value to measure the acceleration of the central portion of any obtained gradient.

Though there are many studies of empirical stimulus generalization with human subjects, most of these are of tangential interest for the present research. Most of the work with human subjects follows the procedures used by Brown and his associates (Brown, Bilodeau, & Baron, 1951; Bilodeau, Brown, & Meryman, 1956; Brown, Clarke, & Stein, 1958). These experiments have used RT and an all-or-none (frequency measure of response). Some of the drawbacks listed for the majority of

studies of stimulus generalization with human subjects are: the limited learning taking place in training; the all-or-none nature of the response measured; the effect of inhibitory instructions or partial reinforcement during training on the shape of the obtained gradients; and the effect of the discrimination-training procedures customarily used beyond the first trial of the generalization test (Bilodeau, Brown, & Meryman, 1956; Mednick & Freedman, 1960).

Thus, though the betting and key-pressing responses used with human subjects have yielded regular functions comparable with data obtained under other procedures, the present project used a different procedure (a) in the hope of offering the human subjects a more difficult transfer-test task and (b) in an attempt to provide the subject with a task for which training would produce a learning curve and generalization tests a continuous measure of strength of response. These are important considerations in view of the project's purposes of testing for empirical gradients beyond a first test trial, using transfer of training procedures (treating responses to the new stimulus as correct) and of comparing gradients developed under transfer-test procedures with procedures treating test responses as incorrect.

The experimental procedures fit the definition of human

voluntary conditioning on the stimulus side, as given by Grant (1964): a reaction-time situation in which a "peripheral" stimulus regularly precedes another stimulus to which the subject is to make a simple voluntary response. However, in Grant's statement of classical voluntary conditioning, the first (warning) stimulus serves as a substitute for the stimulus to the voluntary response--as in evoking false reactions in a reaction-time experiment. The present method emphasizes the role of the warning stimulus as preparation, not substitute, for the second stimulus, and measures both reaction time to the second stimulus and anticipatory changes in pressure in the interval between the two stimuli.

Though voluntary, instructed conditioning is a relatively old topic, particularly in Russia (Razran, 1936; Grant, 1964) and is important enough to warrant inclusion in Grant's analysis of conditioning, it has not always proved easy to demonstrate (Gibson, 1936). One problem long recognized is the inhibitory effect of the conditioned response (as a false reaction) on the further growth of response strength (Yacorzinski & Guthrie, 1937) and the sensitivity of voluntary conditioning to instructions and subject's attitude (Hilgard & Allen, 1938). The preparatory response, though exploratory, may be less subject to criticism on the grounds of inhibitory effect, and may

also be less sensitive to the subject's attitude. Preparing to respond cannot be interpreted as an overt error violating the instructions; additionally, our instructions stated that a false reaction was not a matter for concern. The reaction time of the voluntary response, a measure known to yield a decreasing trend with constant foreperiod in reaction-time studies was also measured as a potential index of the extent to which a peripheral stimulus acquires the function of a warning stimulus and the extent to which this function transfer to other stimuli. The present methodology, however, must be considered exploratory in both its training and generalization-test procedures.

Exp. I: Preliminary Experiment

Method

The design, procedure, and results of Exp. I are briefly summarized below. Exp. I was terminated after 11 subjects were run in each treatment group, so that the apparatus could be improved and a preliminary check made of the suitability of the proposed response measures. Exp. II is essentially a replication of Exp. I, with increased apparatus reliability and more subjects; Exp. I will be most briefly treated, thus, as Exp. II is a more reliable version of the same design. The purpose of Exp. I was to test for generalization in a transfer of training test at a common stimulus value after training at a different stimulus value.

Subjects.--The subjects were 88, paid, volunteer, male undergraduate students at Tulane University.

Apparatus.--The apparatus was a preliminary version of the Tulane Watchkeeping Apparatus described in Appendix A. A buzzer was used to provide S_v, but otherwise, except for the spring-mounting on the response-pressure plate, the apparatus was as described in Exp. II and Appendix A: an auditory S_W whose spatial location was variable in the horizontal dimension; a mock radar display on which any of 20 simulated aircraft could be lighted as S_V; and a hand plate

that the subject was to depress (R_v) as quickly as possible when he saw a lighted aircraft silhouette (S_v). The S_w preceded S_v by 2 seconds, and preparatory responses--releasing or depressing the hand-plate in the interval between S_w and S_v were recorded on an inkwriter; the instructions did not refer to S_w. A clock provided a measure of RT to S_v.

Design.--The variable was the difference in the spatial location of S_w in training and test. All groups received 10 paired presentations of S_w and S_v (S_w at the central position) in a transfer test after 30 training trials in which the locus of S_w differed for the experimental groups and a control group received S_v without S_w.

Procedure.--Seven experimental groups received 30 paired presentations of S_w and S_v (S_v following S_w after a two-second interval) in training, locus of S_w variable from group to group, and 10 presentations of S_v in a transfer test. The interval between successive presentations of S_v varied from 45 to 150 seconds in 15-second steps, with a median of 90 seconds and modal values of 60, 90, and 120 seconds. In training S_w was varied from group to group: 5, 10, and 35 degrees clockwise, 0 degrees, and 5, 10, and 35 degrees counterclockwise from a 0-degree reference opposite the subject's right ear. The S_w was at 0 degrees for all groups in the

test period. A control group received 30 presentations of S_v without the warning signal, S_w, followed by the 10 test trials, paired presentations of $S_w(0°)$ and S_v. Five adaptation trials in which S_v was presented without S_w preceded the 30 training trials.

Results and Discussion

Reaction-time (RT), preparatory increases in pressure between S_w and S_v, preparatory decreases in pressure, and the difference between peak increases and decreases in preparatory pressure were all examined as R-measures that might yield learning trends. Within the reliability of the small number of subjects, RT appeared a good measure, as did the difference (the A-measure of response) between the range of maximum and minimum pressures in the critical interval from S_w to S_v and the range of maximum and minimum pressures in a control interval, the two seconds immediately preceding S_w. Both showed trends over trials with paired S_w - S_v presentations and no trend with presentations of S_v alone. There was no evidence of a gradient of generalization in the test period.

To avoid redundancy with Exp. II, the data of Exp. I are not further treated. Their importance is in the indices

of learning that they suggest as promising in the later experiments, and in the indication that gradients of generalization may not be readily obtained in human subjects with transfer of training procedures.

Exp. II: Transfer of Training Tests

Method

The design and procedure of Exp. II are briefly summarized below. Detailed descriptions of apparatus components are in Appendix A. A copy of the instructions to the subject is given in Appendix B, and details of the procedure are in Appendix C.

The major purpose of Exp. II was to test for generalization and a gradient of stimulus generalization along the dimension of auditory spatial location, using transfer of training procedures in the generalization test. That is, as in Exp. I, Exp. II avoided differential training by continuing paired stimulus presentations, the learning treatment, in the test period; subjects were shifted to a new value of S_W, but _E_ continued to present S_V two seconds after S_W. The transfer test was intended, too, to allow studying the development of a gradient of stimulus generalization, or changes in shape or slope of a gradient in successive test

trials. Experimental groups of subjects were trained with S_W at one of seven positions for 30 S_W - S_V pairings and tested for 10 additional S_W - S_V pairings with S_W at the central position, $S_W(0)$. A control group of subjects received S_V alone in training, and had the same $S_W(0)$ - S_V test as the experimental subjects. A second purpose of Exp. II was to evaluate alternative R-measures for their suitability as indices of associative strength.

Subjects.--The subjects were 192 male undergraduate students at Tulane University, mostly volunteers from the introductory classes in psychology.

Apparatus.--The apparatus was the Tulane Watchkeeping Apparatus, the four components of which are separately described below; the components were built independently so that a variety of display and response panels could ultimately be combined. In the present combination, two stimuli (S_W - S_V) were repeatedly presented close together. The subject was asked to make a voluntary R (R_V), pushing down on a hand-rest, to the second of the stimuli (S_V), any of 20 lights on a glass screen; there was no mention of the first stimulus, (S_W), a low-intensity click from a source close to E's console. Reaction time to S_V, anticipatory Rs, and preparatory pressure changes to S_W were all recorded

as potential measures of learning. The variable manipulated in the generalization test was the difference between S_W's spatial location in training and test.

Auditory display: In Exp. II the click of a magnetic relay, variable in spatial location over 70° of arc (horizontal) provided S_W. The relay was housed in one of a pair of nonfunctioning Standard Electric Timers, ostensibly serving to measure the subject's reaction time. The S_W's onset started an RT clock on E's panel and activated the event marking pen of a Sanborn recorder; the S_V's onset terminated the event-marker signal; and the voluntary R to S_V stopped the RT clock. The click was audible, but of low intensity, and E did not mention it or its function; it was hoped that the subject would associate the S_W clicks with E's console, rationalizing the brief clicks as an accidental failure in the equipment's sound-proofing.

Visual display: The display for the watchkeeping task was a circular glass screen, 12 inches in diameter and divided into quadrants by crosshairs. Behind the glass was a metal plate in which five quarter-inch crosses (airplane silhouettes) had been cut out in each quadrant. Lighting one of the cutouts from behind gave the subject his vigilance signal, S_V, the locus of which could be varied from trial to

trial over the 20 positions. A separate lamp was mounted behind each silhouette, to provide independent lighting for the 20 stimuli.

Response panel: The subject's control was an inclined hand-pressure plate mounted on a tablet armchair, sensitive both to pressure changes (increases or decreases) and to voluntary Rs to S_v. To make an R_v the subject had to push the plate all the way down to close an end switch. Pressures short of this were taken to measure preparatory Rs to S_w. An R_v stopped the RT clock on E's panel and turned off S_v, as well as activating the recorder pen.

Experimenter's console: The E's panel contained silent switches for selecting S_v among the 20, clocks for recording RT and elapsed experimental time, a switch to cut S_w out of the circuit, and a 'start' switch to present S_w - S_v pairs or S_v alone. Decade timers soundproofed in an adjoining room controlled the S_w - S_v interval at two seconds.

Recording: An additional component was a Sanborn single-channel recorder with start-stop event marker. The recorder took movement on the pressure plate for the three seconds of each trial preceding S_w and for as much time after S_v as was required for R_v. Both R_v (completely closing the switch) and smaller hand pressures were recorded; and RT, if needed to

verify the clock reading, could be read from the tracing. The onsets of S_W and S_V started and stopped an event-marker pen, to provide a record of stimulus onsets and a calibration check of the interval between S_W and S_V.

Instructions.--The instructions to the subject described the task as radar watchkeeping, stressed speed, and minimized the importance of false responses. "Your job is to detect the airplane and report its presence as quickly as you can. As soon as you see the airplane, push this alert...The sooner you report it...the better your alertness score. It is better to be fast and make an occasional report of a plane when there is none, than to let a plane remain on the screen undetected. If you do push the button when the screen is blank, just report, 'False alert.' It will not detract from your score." A complete copy of the instructions is in Appendix B.

Design.--A simple, single-variable design with an outside control was used in the training period of a transfer of training experiment. In the training period there was a simple dimensional manipulation of the warning signal's (S_W) spatial location from group to group; in the transfer test the groups were shifted to a common location of S_W. The outside control group was not exposed to paired stimulation until the test period.

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Procedure.--All subjects were given standard instructions and tested individually for a total of 5 adaptation, 30 training, and 10 generalization-test trials. The E presented S_v alone on the 5 adaptation trials in order to give the subject time to settle down and also to let E null the recorder to the individual's resting pressure before the experiment proper began. Intertrial spacing on these trials varied as required, between 30 and 60 seconds, and E had the option of continuing for an additional 5 trials if further adaptation seemed necessary.

The interval between S_w and S_v was 2 seconds on all paired presentations, a value chosen as yielding optimal RT with a ready signal. The median trial duration (watching time elapsing before an S_v presentation) was 90 seconds, varying from 30 to 150 seconds, according to unsystematic, prearranged sequences. Light sequences (position of S_v on the mock radar display) were similarly varied according to unpredictable schedules. Procedures for controlling sequences of lights and trials are described in Appendix C.

There were eight groups of 24 Ss each; the seven experimental groups received paired presentations of S_w and S_v in training and differed in the location of the warning signal (S_w) in the training period. The training positions of S_w

were: 0°, or central (directly opposite the subject's right ear); 5°, 10°, and 35° clockwise from the central position; and 5°, 10° and 35° counterclockwise from the central position. These groups are identified by the difference and direction or the difference, in degrees, of S_w's position in training from the central, 0°, position. The learning procedure (paired S_w - S_v presentations) was continued in the generalization-test period, but S_w was at the central, 0°, position for all seven experimental groups. The eighth group, Group C, received no warning signal until the test period; only the vigilance stimuli were given during its training. The generalization test was identical with the experimental groups' test treatment. Group C provides a baseline for adaptation or other nonlearning effects of S_v presentations against which to evaluate the learning and transfer of the other groups. Table 1 summarizes the groups' treatments.

Results

Alternative response measures as indices of learning.--Because relatively little is known about voluntary conditioning, and because pretest learning and level of learning are of first importance in their implications for tests of gen-

Table 1

Summary of Experimental Design

Experiment II

Group	Pretraining (5 trials)	Training (30 trials)	Test (10 trials)
C	S_v alone	S_v alone	S_w (0) - S_v
35cl	S_v alone	S_w (35cl)-S_v	S_w (0) - S_v
10cl	S_v alone	S_w (10cl)-S_v	S_w (0) - S_v
5cl	S_v alone	S_w (5cl)-S_v	S_w (0) - S_v
0	S_v alone	S_w (0)-S_v	S_w (0) - S_v
5cc	S_v alone	S_w (5cc-S_v)	S_w (0) - S_v
10cc	S_v alone	S_w (10cc)-S_v	S_w (0) - S_v
35cc	S_v alone	S_w (35cc)-S_v	S_w (0) - S_v

(n=24)

eralization, three possible associative indices were measured and considered. Each of the indices is treated below.

False alert responses (FA): False alert responses are complete anticipatory switch closures made between S_W and S_V--i.e., jumping the gun or treating S_W as a substitute for S_V. Table 2 summarizes the frequency of FA responses by 10-trial blocks of training and test for each of the eight groups in Exp. II; trial-by-trial frequencies are given in Table E.1 of Appendix E. Several points are readily apparent in Table 2. (a) Frequency of FAs does depend upon paired presentations of S_W and S_V. Group C produces no FA responses in its 30 trials to S_V alone, while every experimental groups makes some FA responses. And Group C has a frequency of 7 FA responses in the 10 test trials, where S_W and S_V are first paired for this group. (b) The FA measure is not a satisfactory index of learning. The absolute frequency of FA responses is low and varies from as few as two responses per group in 30 training trials to as many as 10. The largest number of FAs in any 10-trial block is eight (Block 1, Group 35cc)--an average of one FA response per three subjects in 10 trials. Two groups (0 and 5cc) [illegible] produce a total of only two FA responses among 24 subjects in the 30 training trials, suggesting that FAs are not only few, but

Table 2

Frequency of False Alert Responses in Successive

10-trial Blocks of Training

and Test for Each Group in Exp. II

Trial	Group								
Training	35cl	10cl	5cl	0	5cc	10cc	35cc	C	Exp.*
1-10	4	3	2	1	2	6	8	0	3.7
11-20	0	1	1	1	0	2	0	0	0.7
21-30	1	4	2	0	0	1	2	0	1.4
Test									
1-10	0	2	3	0	3	2	1	7	1.6

(n=24)

*Mean frequency for all experimental groups combined.

unstable across groups. More important evidence against the FA score as a useful index of learning is the nonmonotonic trend in frequency of FA with trials. Frequency of FA reaches its maximum value in the first 10-trial block (3.7 FAs per group, averaged across the seven experimental groups). Table 3 presents average frequency of FAs per group by pairs of trials, for the control group and for the average of the seven experimental groups, to show the very rapid rise to a maximum with $S_W - S_V$ pairings and an equally rapid drop to a low level of FA frequency. A given frequency of FA would have to be evaluated as pre-or post-maximum in order to determine its level as an associative index.

In summary, then, the frequency of FAs does change with $S_W - S_V$ pairings, though absolute frequency, stability, and trend combine to make FA a poor index of differential associative strength. The FA measure will, thus, receive no further treatment in this report. As an FA response prevented S_V onset on that trial, the FA responses (maximum anticipatory Rs) provided extinction conditions when they occurred so that the declining frequency after the initial increment is predictable. And the low frequency of occurrence of FAs is favorable to the present method. There is,

Table 3

Frequency of False Alert Responses in

Successive Pairs of Trials

in Exp. II

Trials	Frequency of FA	
Training	Experimental*	Control
1- 2	.6	0
3- 4	.9	0
5- 6	1.0	0
7- 8	.4	0
9-10	.9	0
11-12	.1	0
13-14	.1	0
15-16	.1	0
17-18	.3	0
19-20	.0	0
21-22	.3	0
23-24	.4	0
25-26	.3	0
27-28	.1	0
29-30	.3	0
Test		
1- 2	.3	1
3- 4	.3	5
5- 6	.4	0
7- 8	.0	1
9-10	.6	0

*Entries are averaged over seven experimental groups of 24 subjects.

of course, no reason to fear such a partial-reinforcement treatment on acquisition and extinction of the preparatory or partial anticipatory R in general. But in the present experiment, where differential reinforcement is avoided, the smallness of the FA phenomenon is welcome.

Reaction time (RT): Table 4 presents RT in successive five-trial blocks of training and test for each of the eight groups of Exp. II. The data points are the means of the trial medians. Individual-trial medians are available in Table E.2 of Appendix E. Median rather than mean RT was chosen because of the expected skew in RT data and the presence of FAs.

The RT measure is a good index of learning in showing (a) a regular decrease over training blocks for the experimental groups, (b) no decrease in RT (perhaps a trifling rise) for the control group over blocks of S_v presentations, (c) a sharp drop in the control group's RT over the two test blocks, where S_w and S_v were first paired, and (d) all experimental groups, after training with 30 S_w - S_v pairings, superior in both test blocks to the control group.

Preparatory pressure or partial anticipatory responses (A): The measure of partial anticipatory response, or preparatory movement, A, is taken as the difference between pres-

Table 4

Reaction-time in .0001 Min. (Mean of Medians)

in Successive Five-trial Blocks of Training and Test

for Each Group in Exp. II

Trials	Group							
Train	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1- 5	41.6	40.4	42.2	42.3	42.7	43.7	41.8	45.1
6-10	37.8	40.9	39.7	38.8	31.6	41.8	38.0	45.1
11-15	36.7	38.4	38.7	38.6	36.8	39.0	36.5	44.5
16-20	35.2	38.8	38.8	37.9	37.5	39.1	34.5	44.8
21-25	34.7	36.2	37.4	36.2	34.8	37.0	34.5	45.6
26-30	33.9	36.0	35.4	36.8	35.5	36.4	34.4	46.6
Test								
1- 5	33.5	36.8	36.8	36.8	33.4	35.5	35.5	42.3
6-10	33.1	35.8	36.6	35.3	33.4	36.7	32.6	38.1

(n=24)

sure changes occurring in the critical two-second interval between S_w and S_v and a base or control interval, the two seconds immediately before S_w's onset. For each two-second period the maximum and minimum excursions of the pen were measured in arbitrary units, and the absolute difference between the two pressure extremes defined the amount of movement in the interval. The difference between amounts of movement in the critical S_w - S_v and the control pre-S_w intervals defined the A-index of preparatory pressure. If the absolute change in pressure is larger for the S_w - S_v than for the pre-S_w interval of a trial, the sign of the difference (A) is positive; when the amount of movement in the pre-S_w interval exceeds movement in the S_w - S_v interval, A's sign is negative. The A-index, thus, is a measure of the extent to which S_w signals a forthcoming S_v, rather than completely substitutes for an S_v as in the FA index. Subtracting movement in the control interval from movement in the S_w - S_v interval to get A controls individual differences in base-level fluctuation in amount of movement and, more importantly, between-trial trends in this base level. In addition to the control of trial-effects not associated with S_w that Group C offers, then, the A-index itself has a built-in control of non-associative effects of successive trials.

Table 5, which gives mean A by five-trial blocks for each group in training and transfer test, shows A to be a suitable index of learning, though perhaps inferior to RT. (Appendix E, Table E.3 presents mean A by trials.) As in the case of the RT measure, A is a suitable index of learning by all three criteria. (a) The control group shows little or no trend over training blocks, and a large increase in A in the test blocks, when S_w and S_v pairings are introduced. (b) The experimental groups show increasing trends in A over the training blocks. (c) The experimental groups, by and large, exceed the control group in amplitude of A in the test blocks. Though mean A does, thus, vary appropriately with S_w - S_v pairings, the data in Table 5 show considerable variability; and the individual records show considerable trial-by-trial fluctuation, as well as individual failures of any measurable pressure change in the critical S_w - S_v interval. Certainly the A index is worth retaining, but both RT and A should be considered in further work.

Table 6 presents the amount of movement for control and critical two-second intervals--i.e. the absolute difference between the highest peak and lowest trough in the pressure recording, for the S_w - S_v and pre-S_w intervals separately,

Table 5

Mean A in Arbitrary Units

in Successive Five-trial Blocks of Training and Test

for Each Group in Exp. II

Trials	Group							
Train	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1- 5	.3	.1	1.1	1.2	1.2	1.2	.3	-.5
6-10	.5	2.4	1.2	.9	1.5	.5	2.3	.2
11-15	1.4	1.6	.8	2.5	.6	1.8	1.7	-1.3
16-20	2.7	1.5	1.7	2.7	1.9	1.6	1.7	-.6
21-25	2.2	2.3	3.4	3.2	2.2	1.7	3.3	.7
26-30	3.3	1.6	3.0	2.9	3.1	2.8	3.4	.3
Test								
1- 5	3.1	2.4	2.2	2.4	3.0	3.0	2.9	2.1
6-10	2.5	4.2	.8	3.7	3.7	2.0	3.1	1.8

(n=24)

Table 6

Mean Amount of Movement in Arbitrary Units in Pre-S_w and S_w - S_v Intervals Averaged over Five-trial Blocks for Each Group in Experiment II*

Trials	Group 35cl	10cl	5cl	0	5cc	10cc	35cc	C
	Mean Movement in Pre-S_w Interval							
Train								
1- 5	2.2	2.9	3.0	3.0	2.4	2.2	2.6	2.2
6-10	3.1	3.3	3.2	3.5	2.7	3.0	2.8	2.3
11-15	2.7	3.1	4.4	3.5	4.0	3.2	3.5	3.9
16-20	2.6	3.6	3.4	3.5	3.0	3.6	2.8	2.7
21-25	3.0	4.2	3.6	4.6	3.1	3.7	3.1	2.6
26-30	3.5	4.4	4.4	4.1	3.2	4.1	2.8	2.9
Test								
1- 5	3.6	4.6	4.3	4.7	2.9	3.8	2.4	3.6
6-10	3.6	3.4	5.0	3.8	3.1	3.0	2.4	3.5
	Mean Movement in S_w - S_v Interval							
Train								
1- 5	2.4	3.1	4.1	4.2	2.4	3.4	2.9	1.7
6-10	4.0	5.7	4.4	4.4	4.2	3.5	5.0	2.5
11-15	4.1	4.7	5.2	6.0	4.6	5.0	5.2	2.6
16-20	5.3	5.1	5.1	6.2	4.9	5.2	4.5	2.1
21-25	5.2	6.6	7.0	7.8	5.3	5.4	6.4	3.2
26-30	6.8	6.1	7.4	7.0	6.3	6.9	6.2	3.3
Test								
1- 5	6.7	7.0	6.5	7.1	5.9	6.9	5.3	5.7
6-10	6.1	7.6	5.7	7.6	6.8	5.0	5.5	5.3

(n=24)

*Amount of movement is defined as the difference between maximum and minimum pressure readings in the interval.

averaged over blocks of five trials. Clearly the pre-S_w interval does serve as a useful control: in all cases, including Group C, there is a slightly positive trend in amount of pre-S_w movement over trials. Just as clearly, movement in the S_w - S_v interval grows more rapidly with practice, as can be deduced from the trend in the mean difference between movement in these intervals shown previously in Table 5. It is important to recall that Group C showed no trend in A, so that we can reasonably dismiss the possibility that movement (or expectancy based on temporal conditioning) increases over the waiting interval and that our A trend over trials is a phenomenon of temporal expectancy rather than of association to S_w.

Stimulus generalization.--Figure 1 plots mean anticipatory potential, averaged over five-trial blocks, as a function of the difference in training and test stimulus location, for each five-trial block of test trials; the means of group C's test blocks and first training block are indicated as straight, dashed lines to provide reference baselines for evaluating the experimental groups' performance in the test period. Again, relative to group C's training or test performance, all experimental groups show learning. On the first block of test trials all experimental groups exceed group C, on the second block of test trials group C exceeds only group 5cl, and all

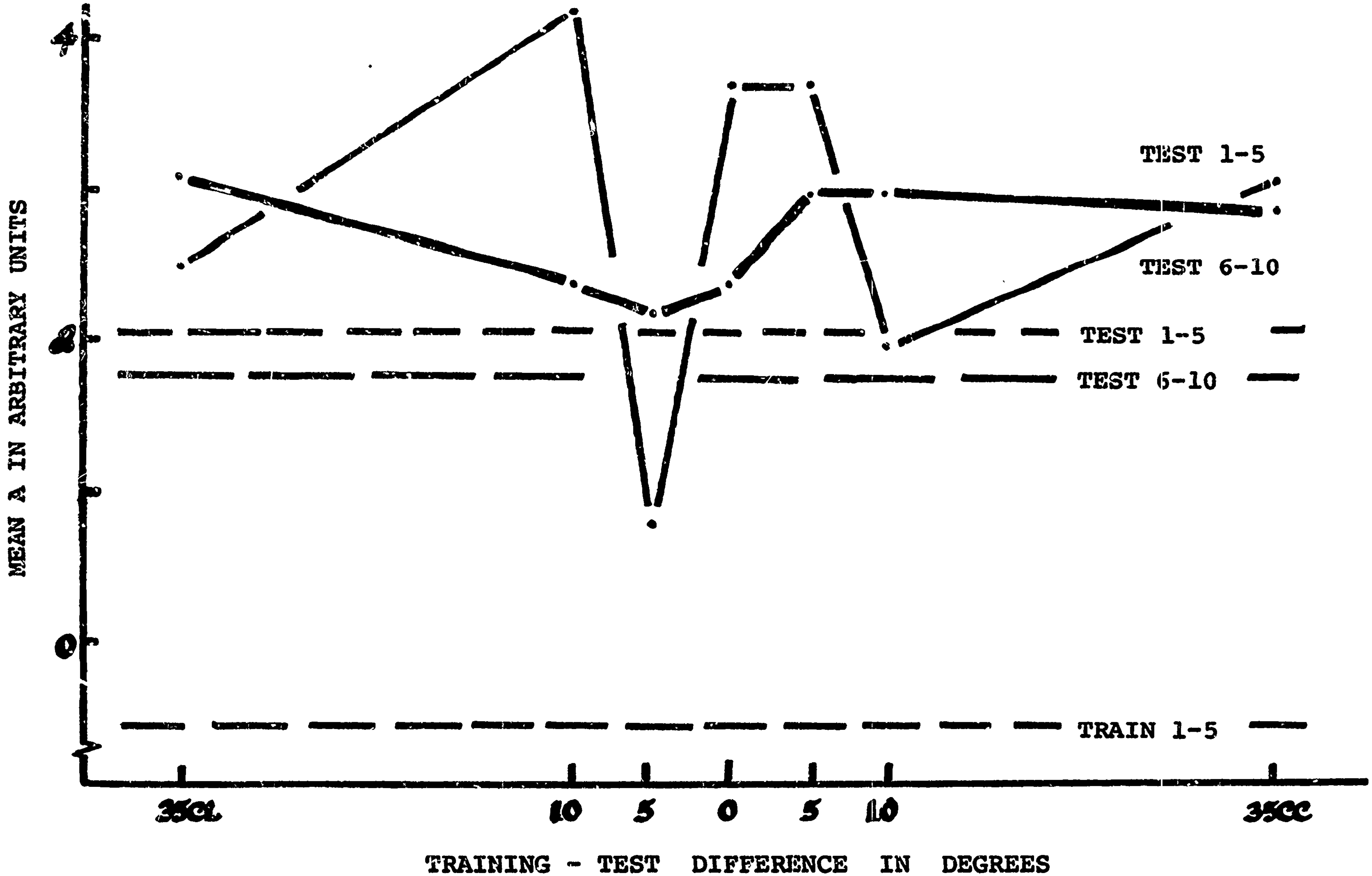

Fig. 1. Mean amplitude of preparatory pressure change as a function of difference between S_W positions in training and test in Exp. II. Test trial, by five-trial block is the parameter. Broken, horizontal lines indicate the level of control-group performance.

means in the test blocks exceed group C's mean for the first block of training trials.

Figure 1, then, supports the hypothesis of stimulus generalization from training on one stimulus to a test on another, i.e., transfer of training took place. But with the present transfer of training method, there is no evidence of a gradient of stimulus generalization. In the first test block, four of the transferred groups have a greater preparatory pressure than group 0; group 0 was trained and tested at the same locus of S_W and should provide the upper limit of performance in the transfer test, as group C the lower. The function is no more regular in the second test block, where group 10cl has the maximum preparatory pressure. That there is no gradient of generalization over the values tested, and no systematic development of a gradient is evident in Table E.3 of Appendix E; an examination of the means of test trials fails to reveal any trend with amount of change in locus of S_W from training to test.

Very similar conclusions can be drawn from the RT data, plotted in Figure 2 for each test block against amount of change in S_W from training to test; selected blocks of group C's average A are again plotted as dashed horizontal lines for reference. Again, learning and stimulus generalization

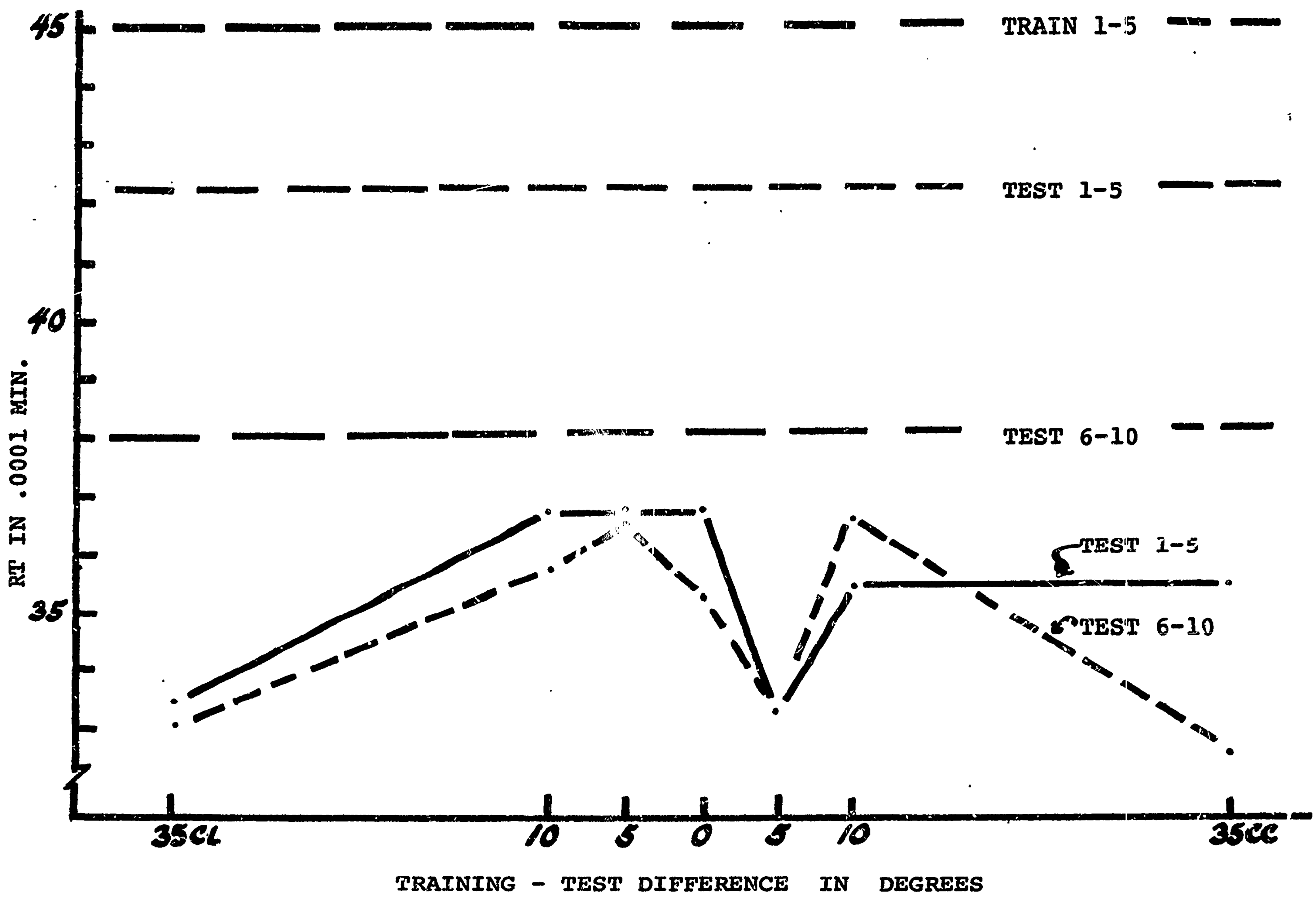

Fig. 2. Reaction time (mean of trial-medians) as a function of difference between S_W positions in training and test in Exp. II. Test trial, by five-trial block, is the parameter. Broken, horizontal lines indicate the level of control-group performance.

(or transfer of training) are evident in comparison with the control group's performance. All experimental groups are superior to group C on both blocks of test trials as well as on the first training block. And again there is no evidence of a <u>gradient</u> of stimulus generalization over the range of values used; the performance of group 0 is roughly average among the experimental groups in RT as well as in A. As in the preliminary study, Exp. I, there is evidence of learning and transfer from one value of S_w to another but no evidence of differential transfer with variation in S_w difference from training to test.

Experiments III and IV:

Extinction and Relearning Tests

The design and procedures of Exp. III and IV are outlined below. Fuller description of apparatus is in Appendix A, instructions are quoted in Appendix B, and procedural details are given in Appendix D. The purpose of Exp. III and IV was to test for generalization under conditions of differential reinforcement: (a) in Exp. III, during extinction of preparatory Rs previously established at a different locus of S_W; and (b) in Exp. IV, during reacquisition of preparatory Rs at the original locus after extinction at a different locus. That is, Exp. II showed generalization in a transfer of training test; after a shift to a new value of S_W, all groups previously given paired S_W - S_V training were superior to an untrained control group. However, there was no evidence of a gradient of generalization either early or late in the test period; transfer of training was complete from any S_W to $S_W(0)$. All groups given 30 S_W - S_V pairings were equal in the $S_W(0)$ - S_V transfer test regardless of physical difference between S_W and $S_W(0)$. The absence of a gradient in the transfer test is ambiguous. (a) That the 'gradient' is flat between values 35°cc and 35°cl from $S_W(0)$ might have implications for the form of the function between amount of

stimulus generalization and amount of difference between original and new stimuli. That is, the function may be convex about center (Spence, 1937) rather than concave upward (Hull, 1943)--or even flat for adult human subjects. (b) Or the gradient of stimulus generalization may be a product of differential reinforcement, the discrimination-training procedures Lashley & Wade (1946) consider necessary to establish a relevant stimulus dimension. Both alternatives receive at least a partial test in either of the experiments suggested as the next step by the outcome of Exp. II: (a) increasing the range of difference between S_W and $S_W(0)$, and repeating the transfer of training test of stimulus generalization, or (b) testing for stimulus generalization under conditions that provide differential reinforcement at S_W and $S_W(0)$. The differential test was selected because it was intended as the next step in the original program and because it provides tests of both hypotheses above. Should differential reinforcement procedures also fail to produce a gradient of stimulus generalization, the hypothesis that the form of the function is not concave upward for human subjects is supported, and the necessity of discrimination training procedures for a gradient is opposed. Should a gradient be obtained under differential reinforcement procedures, then Exp. II's

transfer of training test could not have failed to yield a gradient because all S_w - $S_w(0)$ differences fell on the flat portion of a gradient convex over a wider range. In Exp. III, then, experimental groups were first given S_w - S_v pairings, locus of S_w variable from group to group, as in Exp. II, and were tested under extinction procedures--$S_w(0)$ was not closely followed by S_v. In Exp. IV the same subjects were retrained (S_w - S_v pairings) at their original locuses of S_w. There were S_vs during the extinction test, of course, as watching for S_v was represented to the subject as his task, but S_v bore no temporal relation to $S_w(0)$.

Method

Subjects.--The subjects were 180 naive male undergraduate students at Tulane University, assigned without bias among six treatment groups by the method of successive replications using each group once.

Apparatus.--The Tulane Watchkeeping Device, described in Exp. II was modified so that E could present S_w quite independently of S_v. With the modified device E can give either or both stimuli and in any order--i.e., paired presentations of S_w and S_v, in the order S_w - S_v or, backward, S_v - S_w; S_w alone; S_v alone, or successive presentations of

either S_v or S_w. The instructions to the subject and the arrangement of the apparatus and experimental room were not changed, and the same single pen recorder and timer were used to measure amplitude of the preparatory response and RT to the S_v.

Design.--The design was a simple, single-variable design with an outside control group. Experimental subjects had S_w - S_v training with S_w at position 0°, and 5°cc, 35°cc, 5°cl, or 35°cl from the 0° reference. For the control group, S_v and S_w were not paired. In Exp. III, all groups received extinction treatment with S_w at 0°. In Exp. IV the experimental subjects received S_w - S_v retraining with their original S_w, and control subjects were trained for the first time at S_w(0). Table 7 summarizes the experimental design.

Instructions.--The instructions were the same as in Exp. II. The subjects were told they were taking part in a watch-keeping experiment and that they were to report airplane silhouettes on the mock radar screen as fast as possible by pressing the alert. The instructions are given verbatim in Appendix B.

Procedure.--The procedures of Exp. III and IV are summarized below; additional details are in Appendix D. In Exp. III, the subjects received 3 adaptation trials (or more, as needed)

Table 7

Summary of Experimental Design,

Experiments III and IV

Group	Exp. III Training* (16 trials)	Exp. III Extinction (8 trials)	Exp. IV Relearning (8 trials)
C	S_V	15 $S_W(0)$;8 S_V	$S_W(\ 0\ )-S_V$
35cc	$S_W(35cc)-S_V$	15 $S_W(0)$;8 S_V	$S_W(35cc)-S_V$
5cc	$S_W(\ 5cc)-S_V$	15 $S_W(0)$;8 S_V	$S_W(\ 5cc)-S_V$
0	$S_W(\ 0\ )-S_V$	15 $S_W(0)$;8 S_V	$S_W(\ 0\ )-S_V$
5cl	$S_W(\ 5cl)-S_V$	15 $S_W(0)$;8 S_V	$S_W(\ 5cl)-S_V$
35cl	$S_W(35cl)-S_V$	15 $S_W(0)$;8 S_V	$S_W(35cl)-S_V$

(n = 30)

*Training was preceded by 3 pretraining trials to S_V alone.

to S_V alone. Experimental subjects next had 16 $S_W - S_V$ training trials after which they were shifted to $S_W(0)$ for extinction--15 presentations of S_W not followed closely by R_V. Eight presentations of S_V, in which S_V bore no temporal relation to S_W, were interspersed with the extinction presentations of $S_W(0)$. The subjects of the control group had 16 presentations of S_V alone after the 3 adaptation trials, and then, at $S_W(0)$, received the same extinction treatment given the experimental subjects--15 presentations of $S_W(0)$ in no temporal relation to eight presentations of S_V.

In Exp. IV, experimental subjects had eight $S_W - S_V$ retraining trials at the original S_W; the control subjects received eight paired presentations of $S_W(0)$-S_V.

The interstimulus interval was 2 seconds in both training and relearning and the watching time preceding an S_V varied from 30 to 120 seconds, with a median value of 60 seconds. From the end of pretraining to the last S_V of Exp. IV took 33-1/2 minutes of experimental time; total experimental time was about 45 minutes per subject. Five different sequences of S_V lights and six sequences of trial durations made 30 combinations in which one subject of each group was run.

Results

Reaction time.--Table 8 summarizes the experimental outcome for the RT measure in Exp. III and IV, presenting median RT for the first trial of training, extinction, and relearning, and median RT by four-trial blocks for the last four trials of training, the eight presentations of S_V in the extinction test of Exp. III and in the relearning test of Exp. IV. The quartiles of individual trials of Exp. IV are available in Table E.4 of Appendix E.

Table 8 shows that as in Exp. I and II, paired presentations of S_W and S_V reduce RT in training relative to the control group, and also shows in the extinction test trial blocks that without S_W's warning, RT to S_V falls at once to the original level. With the reintroduction of S_W in the extinction test of Exp. IV, the experimental groups show evidence of their prior learning by remaining superior to group C throughout both trial blocks, though group C gives clear evidence of improvement from the first to the second block of test trials.

The RT measure is of interest only as an indication of learning, S_W's role in decreasing RT to S_V, in Exp. III; it is relevant to stimulus generalization in Exp. IV, when paired presentations of S_W and S_V are reintroduced. Clearly, rela-

Table 8

Quartile Points for RT in .0001 Min. on Selected Trials and Blocks of Trials for All Groups in Exp. III and IV*

Trial			35cl	5cl	0	5cc	35cc	C
Training	1	Q_2	44	44	44	43	43	41
		Q_3	50	49	54	49	51	46
		Q_1	42	40	40	40	38	36
Extinction	1	Q_2	48	49	47	51	48	40
		Q_3	57	54	59	60	57	44
		Q_1	43	40	40	40	41	35
Relearning	1	Q_2	44	43	42	46	40	45
		Q_3	51	48	55	56	47	49
		Q_1	41	38	38	40	36	40
Training	13-16	Q_2	34	35	36	36	38	42
		Q_3	40	39	40	42	42	48
		Q_1	30	32	32	32	33	41
Extinction	1- 4	Q_2	45	45	47	47	47	42
		Q_3	50	50	54	54	58	45
		Q_1	41	41	41	41	43	36
Extinction	5- 8	Q_2	44	45	42	44	48	44
		Q_3	48	49	50	52	52	49
		Q_1	41	42	38	39	40	39
Relearning	1- 4	Q_2	38	40	39	42	40	42
		Q_3	49	44	45	48	46	45
		Q_1	36	34	36	38	36	40
Relearning	5- 8	Q_2	37	34	36	35	36	39
		Q_3	43	39	42	44	46	44
		Q_1	32	32	34	34	33	36

Group columns: 35cl, 5cl, 0, 5cc, 35cc, C

(n=30)

*Trial-block entries are based on individual medians for the trials in the block.

tive to group C, all experimental groups give evidence of transfer of learning from the paired presentations of the training period. However, there is no relation between relearning performance and the magnitude of the difference between the stimulus locus in the extinction series and stimulus locus in the training and relearning series. i.e., there is no empirical gradient of the inhibitory effects of extinction at one stimulus value to relearning at different stimulus values.

Preparatory pressure.--The A measure is relevant in both test periods, as an index of the extent to which S_W signals a forthcoming S_V, and mean A is shown in Table 9 for the last five-trial block of training, the extinction-test presentations of S_W in Exp. III by five-trial blocks, and the relearning trials of Exp. IV by four-trial blocks. In Exp. III, experimental groups show learning in a larger A at the end of training and the beginning of the extinction test than the control group and the redundant learning data are not further treated.

Evidence of the very rapid inhibitory effect of the extinction treatment of Exp. III can be seen in the sharp drop in mean A from the last block of training to the first block of extinction-test trials; this early decrement is followed

Table 9

Mean Amplitude of Preparatory Pressure Change in Arbitrary Units Averaged over Blocks of Trials in Exp. III and IV

Trials		Group 35cl	5cl	0	5cc	35cc	C
		Exp. III					
Training	12-16	2.3	2.5	1.3	0.7	1.8	0.0
Extinction	1- 5	0.6	0.1	0.9	-0.1	0.6	-0.1
Extinction	6-10	0.6	1.4	1.0	0.1	0.2	0.2
Extinction	11-15	0.6	0.3	1.0	-0.4	-0.5	0.1
		Exp. IV					
Relearning	1- 4	0.4	1.7	0.6	0.2	1.2	0.2
Relearning	5- 8	0.8	1.3	1.9	0.7	0.3	0.5

(n=30)

by some recovery in amplitude of A, and then further decrement. Though control performance is not always poorest on trial-blocks beyond the first, the experimental groups' performance tends to remain superior to the control throughout Exp. III, and we may question whether extinction is complete by the end of Exp. III, though loss in A-amplitude is evident. As in Exp. II, there is no regular relation in Exp. III between amount of transfer in the first test block and stimulus change from training to test. Further, despite the evidence of extinction in performance loss from training to test, there is no evidence for the growth of a gradient over successive test blocks under the extinction procedures of Exp. III nor under the relearning procedures of Exp. IV. In Exp. IV, all groups show relearning toward their terminal training level, but neither A-amplitude nor gain in A over successive relearning blocks is related to the difference between the stimulus value at which the preparatory response was extinguished and the value at which the response was reestablished. As there is no consistent trend in amount of generalization or in rate of development of a gradient, statistical tests of what unsystematic between-group differences there are seem unwarranted as they have no explanation other than sampling error.

Conclusions and Implications

The chief conclusions of the research are:

1. Under some conditions, transfer of correct responses can be complete from an original to a new situation. Training, thus, can sometimes be as much benefit in a new situation as in the original learning situation.

2. Under some conditions, resistance to extinction can be as great to generalized as to original stimulus values; i.e., errors or responses that are incorrect in a different situation can be as strongly established as the response to the original stimulus.

3. Under some conditions, transfer of extinction, or correction effects, can be complete and independent of amount of stimulus shift from extinction at one stimulus value to a test at a different value. Extinguishing an error can, thus, be as much benefit to a new situation as to the situation in which the correction was made.

4. Treating responses to one stimulus value as correct and to another stimulus value as incorrect does not necessarily produce a gradient of stimulus generalization in either resistence to extinction or rate of relearning.

These conclusions are restricted to the present procedures, stimulus dimension, and range of stimulus values, pending

further research with greater range of stimulus values and with other dimensions of stimulus variation. That the transfer of training procedures of the present project failed to yield evidence of a gradient of stimulus generalization is less surprising than the absence of gradients in extinction and relearning tests. There has been some reason to believe that differential reinforcement of responses to original and generalized stimuli is responsible for the development of empirical gradients (Baron, 1965). It is generally agreed, at least, that the slope, if not the very existence, gradients depends upon discrimination-training procedures. This, of course, is the reason that the stringent boundary conditions for demonstrating simple, empirical gradients include a subject naive to the stimulus dimension studied and exclude differential reinforcement (Brown, 1965), and the reason spatial locus of auditory stimulation was chosen as the present stimulus dimension. It is recognized that these boundary conditions cannot be met, but only approximated; it would be unrealistic to expect to find adult human beings without a history of experience and differential training with a stimulus dimension. We can only choose a relatively unpopular dimension and avoid differential training during the experimental learning period.

One possible explanation of the complete transfer under either transfer-, extinction-, or relearning tests seems discountable on internal evidence: the hypothesis that the amount of original learning produced by present procedures was inadequate to reveal a gradient. Both latency of response to the voluntary stimulus and amplitude of preparatory pressure to the warning stimulus showed progressive improvement in training and superior experimental to control performance in transfer tests. The latency data, particularly, were consistent from trial to trial and subject to subject. Unless latency is generally a poor index of generalization, as it sometimes is (Brown, Bilodeau, & Baron, 1951; Grim & White, 1965), the amount of pretest learning appears substantial. A second hypothesis to account for the transfer-test data, that complete transfer is the product of treating responses to training and generalized stimuli alike, is contradicted by the absence of gradients in extinction and relearning tests.

The experimental outcome, thus, is consistent with either of two remaining alternative hypotheses, which can be stated as the major implications of the present program of research.

1. Empirical gradients of generalization are bell-shaped, or fairly flat, in the central area, or

2. The presence/absence of empirical gradients (or their

steepness) varies with the stimulus dimension manipulated, as well as with reinforcement procedures in training and test.

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Appendix A

Description of Tulane Watchkeeping Device

Watchkeeping Display and Warning Signal.--The subject's watchkeeping display unit was a 24 x 10 inch mock radar console with a circular, translucent plexiglass screen 12 inches in diameter centered in the hinge-mounted front panel. Horizontal and vertical lines 1/16 inches wide etched into the plexiglass and painted with phosphorescent paint formed a well defined crosshair reference for the subject. A 14 x 15 inch sheet of galvanized tin was hinge-mounted on the inside of the front panel 2-1/8 inches from the screen. A 1/8 inch slot at the back of the panel allowed a 1/16 inch template, to be inserted flush against the back of the translucent screen. Twenty plus signs 1/4 inch in diameter were cut to serve as aircraft silhouettes, the stimuli to which the subject was to make a voluntary R. Five silhouettes were distributed with fairly even density, but not with perfect symmetry, within each quadrant of the circular display, and a twenty-watt lamp was attached by a small magnet to the tin sheet directly in back of each silhouette. A lighted silhouette was the vigilance stimulus to which the subject was to respond by pressing the hand plate to its maximum excursion. Completely depressing the plate activated a switch at

the base of the transformer to terminate the vigilance stimulus (S_v).

Two seconds before a vigilance stimulus appeared, a relay delivered warning click (S_w). The interval between S_w and S_v, though constant at 2 seconds in the present project, can be varied, and another S_w can easily be substituted for the present relay. The relay was mounted in the empty case of a Standard Electric Timer, both for disguise and to keep the click's intensity level appropriately low.

Onset and offset of the warning and vigilance stimuli and a recording device were programmed by three Hunter decade timers wired in series and soundproofed in an adjacent room. The sequence was initiated through a delay circuit by a single switch on E's control console and was terminated by the subject's response to the vigilance stimulus; the warning stimulus was switched off on control trials.* Two Standard Electric Timers were used to monitor the warning-vigilance stimulus (S_w - S_v) interval and the subject's reaction time to the vigilance stimulus. Hand pressure was

*After Exp. II, the device was modified to allow S_w to be given without S_v, by adding a direct switch to S_w. The S_v can be used without S_w in modified or unmodified versions by switching S_w off at E's console.

recorded from about 3 seconds before S_w's onset until the subject responded to S_v by depressing the hand plate to its maximum excursion.

The E varied the position of S_v with a manually-controlled 20-plate, silent selector-switch.

Response Unit (Pressure-Plate).--A linear variable differential transformer (Schaevitz Engineering Type E-300) was used to transmit changes in amount of hand pressure to a Carrier Amplifier Recorder (Sanborn Model 301). The recorder output was linearly related to increases in pressure from 0 to 115.625 grams applied to a 5 x 8-1/16 inch aluminum plate hinge mounted 9-1/2 inches from the forward end of a 6 x 22-1/4 inch plywood panel. The absolute magnitude of recorder output was proportional to the distance of the point of application of pressure from the hinged edge. The aluminum hand plate was supported at 10° from horizontal by the transformer's spring mounted plunger which had a maximum excursion of 5/16 inches. The transformer was mounted perpendicular to the hand plate through the center of the plywood base and 2 inches from the forward edge of the hand plate. The lower part of the transformer extended below the plywood base and was enclosed in a 4 x 5 x 6 inch aluminum case. A 1/2 x 5 x 12-1/2 inch leather-

ette-covered arm rest made of foam rubber was attached to the rear portion of the plywood base, behind the hinged edge of the pressure plate. The entire manipulandum as described above was firmly mounted on the arm of a tablet armchair. An X was marked in tape 2 inches from the front edge of the plate (above the transformer) as the subject's alert, the place to rest his fingers between trials and to press against when vigilance stimuli appeared.

Experimental Arrangement.--The mock radar screen was on a 25 x 30 inch table 30 inches high, putting the center of the screen 42 inches above the floor. The subject sat directly before the display, his face about 30 inches from the screen. The response plate was attached to the tablet arm of the chair. Narrow slats nailed to the floor kept the subject from shifting the chair. The warning stimulus was on a table (30-1/2 x 97 inches and 30 inches high) 20 inches to the subject's right. The *E* allowed a 70° arc of 5-foot radius (taken from the assumed midline of the subject's head) for varying the stimulus position on the table, and marked seven locations (corner outlines for the clock holding S_w) at 0° (directly opposite the subject's right ear), and 5°, 10°, and 35°, both clockwise and counterclockwise from 0°, on the surface of the table.

Appendix A (cont.)

Recorder and programming console were on E's desk, a table 27 x 53 x 28 inches high, behind and parallel to the table holding the warning stimulus. The nearest corner of E's table was about 4-1/2 feet to the subject's right. A 48-inch length of half-inch plywood extended 20 inches above E's table to shield E's console and recorder from the subject. The E could monitor the subject, yet the subject could not watch E.

Overhead lighting was off during experimental sessions and E used an 18 inch double-tube fluorescent lamp (Art Specialty Co.) on his table. The plywood screen served also to cut down the amount of light the subject received from E's lamp. An airconditioner to the subject's rear right provided masking, background noise.

Calibration and Maintainance.--The device was always warmed up before a subject was run and recorder, pressure plate, and control console given standard checks. Weekly, or as needed, the alignment of S_V lamps behind the template was checked and lamps realigned as required; the connections of the light (magnet and plate where magnet rests) were gently sanded twice a month. The interval between S_W and S_V was monitored for each subject during the experiment, as were RT

and trial-time clocks against each other and against a stop watch. Once a month the E calibrated the pressure-plate and transformer, checking resting angle and the relation between weight on the response plate and displacement on the recorder over the full range.

Appendix B

Instructions for Tulane Watchkeeping Device

"Please sit here while I explain your job." (*E* has *S* sit before the screen.)*

"This is a vigilance test, a test of your alertness under conditions of prolonged watching. From time to time the image of an airplane will appear on this radar screen. Your job is to detect the aircraft and report its presence <u>as quickly as you can</u>. <u>As soon as you see</u> the airplane, push this alert button." (*E* points to *X*) "When you push the alert the aircraft will disappear. I will measure your reaction time, that is, how long the aircraft stays on the radar screen. The <u>sooner</u> you report it by pushing the alert button the better your alertness score.

"The airplane may appear anywhere on the screen, and at any time so you must be ready to detect and report it as soon as possible. It is better to be fast and, now and then, report an aircraft when there is none than to let one remain on the screen undetected. If you do push the button when the screen is blank, just say, 'False alert.' It will not detract from your score.

*Items in parentheses indicate *E*'s actions at the given time.

Appendix B (cont.)

"During the test you will sit as you are. Just face the radar screen and take a comfortable position...put your arm on the rest and your finger on the alert button"...(E has S take position with finger on X, the 'alert button', arm in resting position)..."Good...Try pressing the alert...

"Do you have any questions?"...(Repeat as required from instructions. Define words if need be)..."I have some (questions) for you.

"What do you watch?...

"Why?...

"When do you push the alert button?...How far?...Show me...Good.

"What do you do after you push the alert button?

"Between alerts where do you rest your arm?...Where do you keep your hand?...Show me...Good.

"Must you keep your finger on the alert button at all times?...Just to make sure that everything is clear, I am going to put a plane on the radar screen. Get in position." ...(E then goes to E's panel) "Ready" (E presents a vigilance stimulus without warning signal) "Any questions now? ...Stay in position." (E douses lights)..."The vigilance test has started..."

Appendix C

Procedural Details of Exp. II

Controlling Sw.--Rather than use different relays at the different spatial locations and risk introducing small, unwanted differences between training and test stimuli, E used a single relay to provide S_W at all locations and moved the relay by hand from training to test position. The relay was put at the proper training position before the subject entered the experimental room and was moved to the test position at the end of training. There were two safeguards to make the change seem neutral to the subject. (1) The relay, housed in an empty clockcase, was one of two 'timers' on a table between E and the subject. (2) The E left his console, picked up the timers, and pretended to read and record scores from them halfway through training (after trial 15) as well as at the end of training. The case holding S_W was replaced at its experimental location after the first pretended reading and at the 0° location after the pretended reading at the end of training. (The E took a third pretended reading at the end of the test, before dismissing the subject.) The E went through these procedures for all eight groups.

Durations of trials.--To prevent the subject's developing a temporal expectancy that could mask the effect of

Appendix C (cont.)

S_W - S_V pairings, the watching time alloted to a trial varied from 30 to 150 seconds, with a median of 90 seconds. (The time elapsing from the Jth to the J + 1th S_V was defined as the duration of watchkeeping trial J + 1.) Table C.1 gives the frequency distribution of trial-durations. From the distribution in Table C.1 two different 40-trial sequences were constructed with a table of random numbers. Two restrictions were imposed. (1) So that E would have time to reach the S_W and return to his console, 120-second trials were assigned to training trial 16 and test trial 1. That is, 120 seconds elapsed between training trials 15 and 16 and between training trial 30 and test trial 1. (2) To control effects of trial duration and sequence of trial durations in comparing training and test performance within groups, and of initial S_W - S_V pairings of control and experimental groups, the sequence of trial durations for the first 10 training was repeated for the 10 test trials.

One 40-trial sequence of trial durations (temporal sequence 1) was used for the first 96 subjects; temporal sequence 2 was used for the remaining 96 subjects. From the end of adaptation to the last S_V of the transfer test took 54 minutes; total experimental time was about an hour and a quarter per subject.

Appendix C (cont.)

Table C.1

Distribution of Trial Durations

in Exp. II

Trial duration (seconds)	Frequency (occurrences in 40 trials)
30	6
45	1
60	10
75	1
90	10
105	2
120	9
150	1

Appendix C (cont.)

Sequence of Sv presentations.--Sequence and frequency of presentation of the 20 S_v lamps were also controlled. Twelve different sequences of presenting the S_v lamps were made from a master 40-trial sequence employing each light twice, once in each half of the master sequence. Each of the 12 lamp sequences was used with 8 subjects in the first temporal sequence and 8 subjects in the second temporal sequence. The master light-sequence was made by breaking the 40 trials into 10 sets of 4, representing each quadrant once in a set, and assigning each of the 5 lamps with a quadrant to represent the quadrant once in the first 5 sets and once in the second 5 sets. To make the 12 running sequences, the master light-sequence was treated as an endless loop, in which 12 starting places were arbitrarily chosen. Six of the running sequences proceeded clockwise around the loop, while the other 6 were counterclockwise. The first 30 lights thus taken from the master sequence were used in training and the first 10 lights were repeated for the test, in order to hold S_v light constant in within-group comparison of test and initial training performance and in control-experimental comparison of respective initial S_w - S_v pairings. If, as occassionally happened, one of the lights failed to function,

it was replaced in the sequence by the lamp (not necessarily in the same quadrant) closest to it on the display.

Treatment order.--The sequence in which the subjects would be run was predetermined according to 24 successive, different, testing sequences employing each of the 8 treatments once. An 8-subject treatment sequence was one row of a Latin square, in which each treatment appeared just once in every row and every column and in which a treatment preceded and followed each of the other treatments about equally often. The 8 columns of 3 different squares were scrambled with a table of random numbers for the complete order of 24 sequences of 8 subjects each.

Appendix D

Procedural Details of Exp. III and IV

Duration of trials.--As in Exp. II, a trial included the waiting or watchkeeping period preceding the S_V and a trial's duration was the time between S_Vs; training trial 1, for example, began with the end of the last S_V of adaptation, the duration of trial 2 was the time between the first and second S_Vs, etc. The durations of the 16 training trials varied from 30 to 120 seconds, with a median of 60 seconds, as shown in the frequency distribution in Table D.1. With a table of random numbers, three different sequences were made of the trial durations in Table D.1, and the counterbalance of each sequence was taken to give six different temporal sequences of 16 trials. These sequences were used equally often (each with a total of 30 subjects, i.e., 5 per treatment, per sequence).

The first eight-trial sequence of trial-durations in the training sequence's counterbalance were used in the extinction test of stimulus generalization (Exp. III), and the first eight trials of the training sequence were repeated in the relearning test of generalization (Exp. IV). The frequency distribution in Table D.1, thus, represents the durations of the 16 test trials of Exp. III and IV combined, as well as of the 16 training trials.

Appendix D (cont.)

In summary, possible effects of trial duration are controlled by using seven different values of trial duration for every subject and six different sequences of these trial durations across subjects. Sequence of trial-durations is controlled within subjects for comparing learning with relearning, the same sequence of durations being used in relearning as in the first eight learning trials. The extinction test controls for trial-duration across subjects, using the learning sequence of one subject as the test sequence of a different subject.

<u>Intervals between events within trials</u>.--In the extinction test of Exp. III there were 15 presentations of S_W as well as the eight presentations of S_V. In the extinction test a trial contained 0, 1, 2, or 3 presentations of S_W, the last S_W of a trial preceding S_V by 10, 15, 20, 25, 30, 35, or 40 seconds. Other adjacent within-trial events were separated by at least 10 and no more than 50 seconds. Table D.2 gives the frequency of interevent intervals for each kind of event pair, totaled across the six test sequences. The duration of a trial determined the number of presentations of S_W preceding S_V on the trial: 0-1 on 30-second trials; 1-2 on 45-second trials; 1-3 on 60-second trials; 2-3 on 75- and

Appendix D (cont.)

90-second trials; and 3 presentations of S_w on 105- and 120-second trials. Three of the sequences had the last unpaired S_w after the last S_v of the extinction test (by 15, 30, or 40 seconds) and one sequence had the last two unpaired S_ws following the terminal S_v (by 30 and 50 seconds, respectively). Table D.3 presents the frequency with which various numbers of S_ws occurred in trials of the several durations.

Clearly E made the choice of following the definition of a watchkeeping trial, a trial as defined to the subject--i.e. the appearance of S_v--in scheduling events in the extinction test of Exp. III. The durations of watchkeeping trials in the extinction test were from the same distribution as pre-S_v watching in learning and relearning. The presentations of S_w were therefore more massed in the extinction test of Exp. III than they were in original learning or in the relearning test of Exp. IV.

Sequence of Sv lights.--Six different sequences of 16 lights were used to control which of the 20 S_v lamps were used in training and their order of appearance. The first eight lights of the training sequence were repeated in the relearning test of Exp. IV, to hold effects of S_v light constant in comparisons of learning and relearning. In the

Appendix D (cont.)

extinction test of Exp. III the first eight S_vs of the next sequence of lights was used, so that learning and extinction can be compared with effects of S_v lights controlled between subjects. To make the six different light series _E_ combined five 4 x 4 Latin squares representing each _quadrant_ once in every row and every column with five 4 x 5 code-tables assigning lights within quadrants. The code tables were made by making a 5 x 5 Latin square for the five S_vs of each quadrant, dropping the bottom row of the complete square and assigning one 4-cell column of each 4 x 5 (within-quadrant) table to each code table.

Treatment sequence.--Each of the six sequences of trial-durations was combined with each of the five S_v light-sequences, and six subjects, one subject per treatment, run under each of the 30 combinations of S_v light and trial-duration. The temporal sequences were used successively, i.e. temporal sequence 1 was used once per treatment with each light sequence then temporal sequence 2 was repeated once per treatment for each light sequence, etc. The order in which the light sequences appeared was randomized within each temporal sequence. The subjects were assigned to treatments from five 6 x 6 Latin squares whose intact columns were put into arbitrary sequence with a table of random numbers.

Table D.1

Frequency Distribution of Trial-Durations

in Training

Exp. III and IV

Duration of trial (seconds)	Frequency of occurrence
30	3
45	4
60	3
75	2
90	2
105	1
120	1

Table D.2

Frequency Distribution of Intervals between Adjacent Events in the Extinction Test, for the Various Pairs of Events, all Sequences Combined, in Exp. III

Interevent Interval (seconds)	Frequency of Occurrence: Event Pair S_W-S_V	S_W-S_W*	S_V-S_W**	S_V-S_V
10	4	4	8	0
15	12	6	10	0
20	9	11	13	0
25	7	5	7	0
30	6	7	7	4
35	4	2	0	0
40	2	5	1	0
45	0	1	2	0
50	0	1	0	0

*Includes one interval between a pair of S_Ws given after the last S_V of the extinction test.

**Includes intervals from last training S_V to first test S_W.

Table D.3

Frequency Distribution of Number of S_W Presentations in Extinction-Test Trials of Different Durations, all Test Sequences Combined in Exp. III*

Duration of Trial (seconds)	Frequency of Occurrence: Number of Sws 0	1	2	3
30	4	5	0	0
45	0	10	2	0
60	0	1	7	1
75	0	0	3	3
90	0	0	3	3
105	0	0	0	3
120	0	0	0	3

*A total of 5 presentations of S_W were given after the last S_V of the extinction series.

Appendix E

Tables of Data

Table E.1

Frequency of False-Alert (Complete Anticipatory)

Responses by Trials

for Each Group of Exp. II

Trial Training	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1							1	
2	1					2		
3		1	1			1	2	
4					1			
5		1				1	1	
6	2						2	
7					1	2		
8								
9	1		1					
10		1		1			2	
11			1					
12								
13								
14						1		
15				1				
16								
17						1		
18		1						
19								
20								
21								
22		2						
23						1		
24	1						1	
25		1						
26			1					
27							1	
28								
29		1						
30			1					

Table E.1 (cont.)

Test	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1						1		
2			1			1		1
3					1		1	5
4								
5		1				1		
6					1			
7								
8								1
9			2					
10		1			1			

(n=24)

Table E.2

Median Reaction Time (.0001 Min.) in Successive Trials

for Each Group of Exp. II

Trial Training	Group							
	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1	41.5	41.0	45.0	46.0	46.0	46.0	46.0	43.0
2	42.0	41.0	42.0	43.5	45.5	42.0	42.0	45.5
3	43.0	38.0	38.5	41.0	42.0	43.5	41.5	46.0
4	41.5	41.0	43.5	42.0	41.0	44.0	40.0	46.0
5	40.0	41.0	42.0	39.0	39.0	43.0	39.5	45.0
6	40.5	42.0	41.0	40.0	40.5	47.0	40.5	47.0
7	36.0	42.0	40.5	38.5	37.5	42.5	38.0	42.5
8	36.5	41.5	42.0	39.0	38.0	39.0	37.5	46.5
9	38.0	42.0	38.0	40.5	43.0	40.0	38.5	45.0
10	38.0	37.0	37.0	36.0	39.0	40.5	35.5	44.5
11	38.0	39.5	38.5	41.5	34.5	40.5	39.0	45.0
12	37.0	36.0	38.5	38.0	39.0	40.0	36.5	47.0
13	37.5	39.5	40.0	39.5	36.5	39.0	35.0	44.0
14	37.5	39.5	38.5	35.5	37.5	36.0	34.5	40.5
15	33.5	37.5	38.0	38.5	36.5	39.5	37.5	46.0
16	36.5	38.5	40.0	39.5	39.0	39.0	36.0	44.0
17	35.5	36.0	37.5	36.0	34.5	38.0	36.0	43.5
18	34.0	40.5	37.0	35.5	37.0	38.0	33.0	43.5
19	35.0	40.0	39.5	39.0	37.0	37.0	33.0	46.0
20	35.0	39.0	40.0	38.5	40.0	38.5	34.5	47.0
21	36.0	37.0	36.0	36.5	33.0	34.5	35.0	46.5
22	35.0	37.0	40.0	35.5	35.5	38.0	37.5	44.5
23	35.0	35.0	36.0	36.5	34.5	37.0	32.0	48.0
24	33.0	34.0	35.5	34.5	34.0	38.0	33.0	42.5
25	34.5	38.0	40.5	38.0	37.0	37.5	35.0	47.0
26	36.0	35.5	34.5	36.0	37.0	38.0	36.0	50.0
27	31.0	37.0	34.0	36.5	34.0	36.5	32.0	47.5
28	34.5	38.0	36.5	37.0	34.5	36.0	34.0	44.5
29	35.0	34.0	37.5	38.0	35.0	36.0	35.0	46.0
30	33.0	35.5	34.5	36.5	37.0	35.5	35.0	45.0

Table E.2 (cont.)

Test	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1	35.0	38.0	40.5	35.5	32.0	34.5	34.0	45.5
2	32.0	36.5	35.5	38.0	34.5	34.0	34.5	42.0
3	35.0	36.0	38.0	37.5	34.0	35.0	34.0	39.5
4	33.5	37.5	33.0	36.5	35.5	36.5	34.5	45.5
5	32.0	36.0	37.5	36.5	31.0	37.5	35.5	39.0
6	33.0	38.5	39.0	36.0	36.5	36.0	34.5	42.5
7	32.0	35.5	37.0	34.5	33.5	36.5	31.0	37.5
8	32.5	35.5	35.0	36.5	31.5	36.5	33.5	36.0
9	34.0	33.5	36.5	34.5	34.0	36.5	32.0	38.0
10	34.0	36.0	35.5	35.0	31.5	38.0	32.0	36.5

(n=24)

Table E.3

Mean Amplitude of Preparatory Pressure (A)

in Arbitrary Units on Successive Trials

of Training and Transfer Test

for Each Group in Exp. II

Trial	Group							
Training	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1	-.04	-5.41	1.08	-1.04	-.68	1.08	-.14	-1.75
2	.69	-1.35	1.62	1.06	-.35	1.87	-1.72	.12
3	-1.46	1.14	.64	1.14	.22	1.12	.56	.12
4	.62	-1.22	2.12	1.47	-.20	.85	.29	-.91
5	1.50	2.58	2.08	3.60	.95	.10	2.62	-.12
6	1.52	4.02	.64	-.10	2.66	1.08	1.89	-.83
7	-1.22	.07	-.95	.64	2.07	-.58	1.50	-1.56
8	-.72	3.35	1.68	1.16	2.00	-.10	3.66	-.58
9	1.35	2.68	3.02	.18	.91	1.43	2.10	2.29
10	1.81	1.77	1.64	2.45	-.27	.60	2.10	1.39
11	.27	1.00	2.81	2.60	.97	1.35	-.22	-1.27
12	1.60	1.77	.06	.83	-1.29	1.89	.66	.06
13	1.25	3.08	.43	2.70	2.33	1.81	3.00	-1.10
14	2.10	.80	.16	3.04	.66	3.50	2.62	-1.95
15	1.64	1.80	.52	3.16	.39	.58	2.58	-2.12
16	2.58	1.47	1.99	3.18	1.75	1.64	.60	-.04
17	2.58	2.43	-.12	1.00	1.25	2.02	1.90	-.68
18	3.33	2.08	1.27	3.58	1.12	3.02	-.47	-.62
19	2.79	.97	3.00	2.91	1.08	.39	2.06	-1.41
20	2.27	.66	2.35	2.87	4.43	1.10	4.64	-.20
21	.25	1.45	1.91	4.72	-1.16	2.10	1.85	2.60
22	2.02	3.85	4.70	3.08	3.22	1.22	5.16	-.87
23	1.62	.08	2.72	3.39	2.12	1.79	2.10	.25
24	3.87	4.43	3.25	2.89	2.60	1.14	5.81	.02
25	3.10	1.85	4.54	1.83	3.14	1.08	1.50	1.31
26	2.04	2.58	1.45	3.58	3.22	2.39	3.66	1.87
27	4.50	1.33	5.52	1.93	3.27	1.50	5.12	-.97
28	3.91	-1.08	2.91	4.87	4.27	3.43	2.91	-.52
29	2.04	2.72	4.66	1.35	1.58	2.14	-.04	.70
30	4.00	2.77	1.27	2.81	3.08	4.60	5.27	.60

Table E.3 (cont.)

Trial	Group							
Test	35cl	10cl	5cl	0	5cc	10cc	35cc	C
1	1.08	2.58	1.66	4.02	.72	4.93	2.81	- .37
2	2.20	3.75	2.12	1.97	4.30	.02	2.56	2.58
3	4.91	2.29	1.72	1.47	4.85	1.50	4.12	2.70
4	4.15	2.52	2.77	1.38	3.83	3.62	1.56	3.47
5	3.20	.60	2.89	2.91	1.25	5.02	3.43	2.25
6	1.72	4.10	1.68	2.39	6.81	2.22	2.08	3.43
7	1.29	5.52	- .37	3.95	.91	.81	2.37	.50
8	5.18	3.35	.91	5.22	3.22	.79	3.93	1.64
9	2.08	5.97	.22	3.89	4.41	4.87	2.45	2.18
10	2.08	5.97	.22	3.89	4.41	4.87	2.45	2.18

Table E.4

Reaction Time Quartiles in .0001 Min. on Successive Trials for Each Group in Exp. III and IV*

	Group					
Trial	35cl	5cl	0	5cc	35cc	C
Training			Exp. III			
1	44	44	44	43	43	41
	50	48	54	49	51	46
	42	40	40	40	38	36
2	44	43	40	45	45	42
	50	48	50	50	50	46
	37	37	35	38	39	38
3	43	42	42	42	43	46
	50	45	51	48	55	53
	35	38	34	35	38	40
4	43	43	41	40	40	44
	50	46	47	43	48	52
	34	39	35	32	36	38
5	39	43	39	41	40	43
	43	46	45	46	46	48
	34	39	35	35	36	38
6	35	39	38	39	40	43
	44	45	47	44	48	46
	32	32	33	36	37	[illegible]
7	40	40	40	40	41	43
	53	47	48	49	46	50
	33	32	32	34	33	38
8	41	39	39	39	40	43
	54	44	49	46	48	49
	33	35	31	36	34	40
9	37	36	36	37	38	41
	44	42	43	42	43	45
	34	30	32	32	32	38
10	38	35	36	36	40	45
	44	40	41	40	46	52
	33	32	32	33	33	36
11	37	38	36	43	38	45
	51	47	44	48	43	53
	33	34	31	33	34	37

Table E.4 (cont.)

Training	35cl	5cl	0	5cc	35cc	C
12	36	37	37	37	39	41
	44	40	48	42	43	44
	33	32	33	33	34	38
13	38	41	36	38	39	51
	49	53	51	43	48	58
	34	34	30	34	34	44
14	37	34	34	36	37	41
	46	42	37	43	40	45
	29	32	28	33	33	38
15	32	35	34	36	39	44
	38	37	42	42	44	50
	30	32	31	31	33	40
16	32	36	38	34	37	41
	38	40	43	38	40	46
	30	30	31	30	31	38
Extinction						
1	48	49	47	51	48	40
	57	54	59	60	57	44
	43	42	40	40	41	35
2	44	44	44	48	47	41
	50	53	52	58	58	46
	39	42	40	40	42	38
3	46	44	48	45	49	43
	61	52	52	52	66	48
	38	39	43	38	40	37
4	43	43	44	44	46	44
	54	50	53	50	58	48
	39	38	39	40	40	37
5	42	45	41	47	45	41
	46	54	49	57	49	48
	38	41	38	40	41	36
6	44	44	46	44	47	41
	50	50	58	50	68	48
	40	40	40	40	41	38
7	44	46	41	42	49	49
	49	54	51	50	56	61
	41	40	37	38	42	42
8	46	44	42	45	46	42
	54	48	50	51	56	49
	38	38	38	37	39	40

Table E.4 (cont.)

Relearning	35cl	5cl	0	5cc	35cc	C
			Exp. IV			
1	44	43	42	46	40	45
	50	48	55	56	47	49
	41	38	38	40	36	40
2	39	38	40	40	40	46
	48	42	49	47	50	46
	34	34	37	38	35	40
3	38	39	39	40	40	40
	40	45	49	52	52	45
	32	34	35	36	33	38
4	39	36	36	39	39	39
	46	41	41	43	48	42
	33	32	32	35	36	35
5	38	35	37	36	38	36
	43	39	44	42	44	41
	31	31	32	34	32	34
6	38	36	38	38	38	40
	44	41	45	44	44	48
	32	32	34	31	34	36
7	39	35	38	36	34	40
	42	42	45	40	46	48
	30	32	34	32	30	35
8	35	35	36	36	37	38
	40	46	40	48	50	48.5
	31	32	36	31	32	33.5

(n=30)

*Quartiles are in the order: Mdn, Q_3, Q_1 on every trial.